GREEN COMPUTING PERFORMANCE ANALYSIS IN HEALTHCARE SERVICES USING CLOUD COMPUTING

A Synopsis

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Abstract:

The information technology in healthcare become trustful and more reliable with the advancement in technology. The cloud computing is one of the advance information technologies which is comprises of large number of computers and connected with real time communication such as internet.This is also known as distributed computing which transfer data from one source to another which can be access and controlled by authorized users in healthcare organization. As advancement in technology comes with some limitation and data security, reliability and privacy are some of the hot issues which are existing in cloud computing. The proposed study analyses the various factors affecting cloud computing security and comparative analysis of existing algorithms will be performing to find out the most suitable algorithm for cloud computing security in healthcare.

1. Introduction:

1. 1 Cloud computing in healthcare

The healthcare sector is rapidly growing in importance and plays an important role in world's economy. This sector makes heavy use of technology including the social media. Technological advances have revolutionized the healthcare industry worldwide – from modern testing techniques to improved surgical equipment, remote health monitoring technologies with the help of modern digital equipment, etc. There are many online healthcare portals. These portals provide the information about patients in a secured way. Data Science, Big Data, Analytics, and Cloud Technology can be used in healthcare to significantly improve a hospital's IT Energy Efficiency along with information on the best ways to improve energy efficiency for healthcare in a cost effective manner.

The rapid innovations in virtualization and distributed computing, as well as improved access to high-speed Internet, have accelerated interest in cloud computting. In the new information technology(IT),Cloud computing provides technique to perform the healthcare service in a tactful manner and decrease carbon dioxide path which also reduce the cost of information technology (IT), and on the basis of demand it deliver computing services.(*Maslin Masromet al.,* 2016).

Cloud Computing define both the term that is form of application and platform. In cloud computing platforms configures and reconfigures the servers which can be virtual or physical machines. In the Cloud Computing powerful servers and large data centers are used to define applications that can be accessible through the internet *(Boss et al., 2007).*

As per the National Institute of Standards and Technology (NIST),"Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers,storage, applications, and services). That can be rapidly provisioned and released with minimal management effort or service provider interaction".*(P. Mell et al., 2009)*

Buyya has defined cloud computing as, "Cloud is a parallel and distributed computing system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements (SLA) established through negotiation between the service provider and consumers."*(R. Buya et al., 2009)*

The cloud computing enables communication at anytime and everywhere which is continuously available to share information from one platform to another.It creates a prospect for information portability within various medical devices exist in health organizations with another rmedical device deployed at other health organization. Cloud computing infrastructure enables to extract the various database of treatment, patients and diseases, that can be easily acceseble to doctors to perform investigation and to understand statistical outcomes. The another system provides access which is connected with database server. This required lot of information, data and computing controling the healthcare field. This technology provide patient historical data at the time of treatment . When patients moves from one department to another for several investigations and tests than it lead to high rate conversation of information between various medical departments. This technology enables clinicians to provide whole health information about the patients for performing comprehensive and precise treatment.

In present, Hospital Information Systems (HIS) is an essential part of healthcare sector ,whereas Electronic Medical Records (EMR) are performed for computer aided operations and remotely located patient care. With the development of IT in healthcare digital data challenges are faced by the industry but also with the help of cloud computing they are able to offer various healthcare services that can be utilize for the better outcomes*(N. John et al., 2014)*

1.2 Cloud Service Models:

To avail the services of the cloud computing a hospital must save all the information on clouds.Cloud encompasses several variations of service models (i e., IaaS, PaaS, and SaaS) and deployment models (i.e., private, public, hybrid, and community clouds).

- ***Infrastructure as a Service (IaaS)*:** These cloud model comprises of networks,storage,processing and other computing infrastructure properties. In this basic infrastructure can't manage and control by users, but they control the functionings perform by applications.

- ***Platform as a Service (PaaS):*** This includes use of specified programming languages and tools into the cloud computing infrastructure which empower users to imply and develop various applications.In this basic infrastructure can't manage and control by users, but they control the functionings perform by applications.

- ***Software as a Service (SaaS)*:** These cloud model permits users to access applications running on a Cloud infrastructure from various end-user devices (generally through a web browser). The user does not manage or control the original Cloud infrastructure or individual application capabilities other than limited user-specific application settings.("NIST Cloud Computing Reference Architecture Ver1.0")

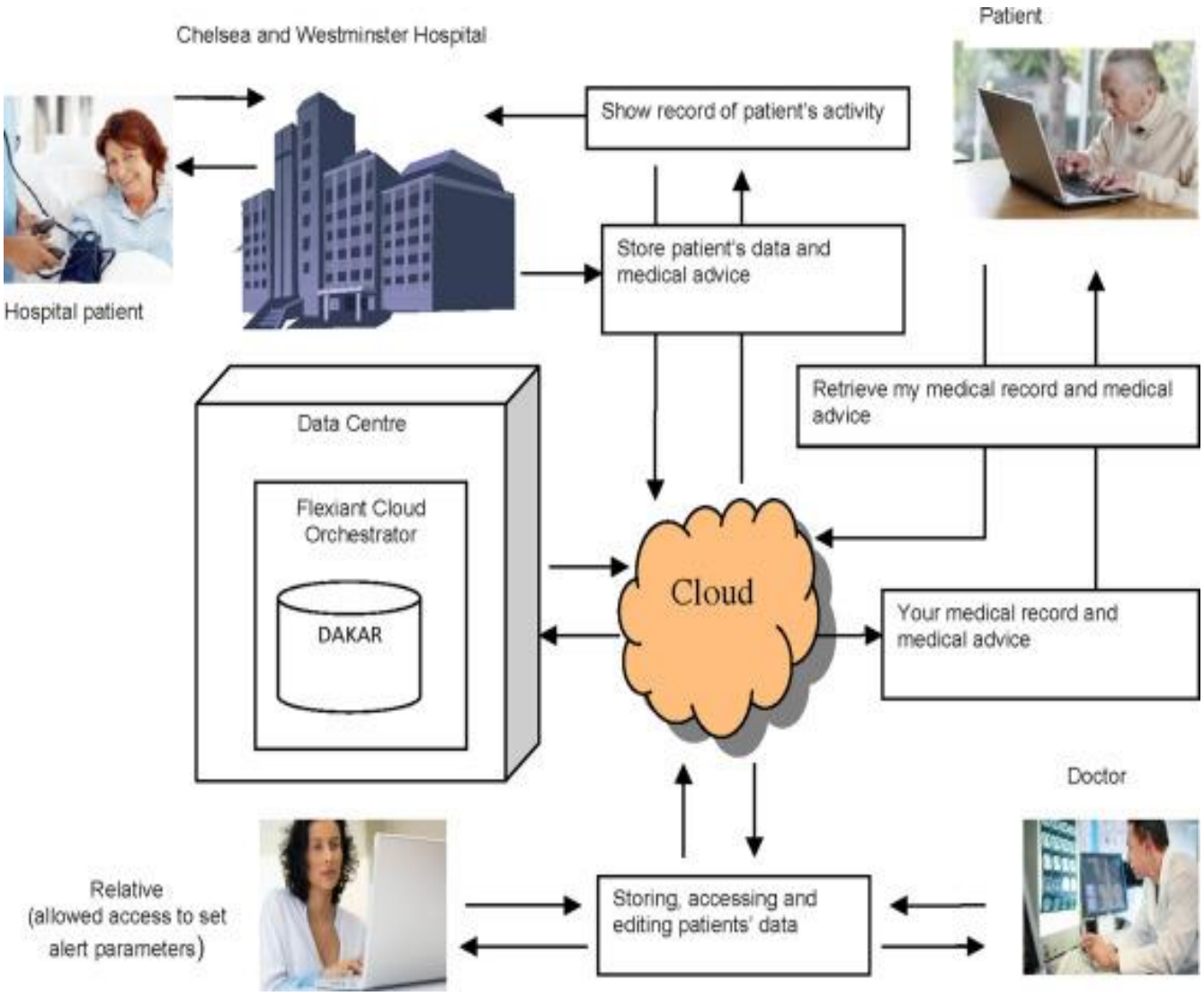
1.3 Deployment Models in Cloud Computing:

The various methods of deploying cloud computing models:

•***Private clouds*** is functionalized by its authorized users or by single organisation. The basic infrastructure of private cloud computing may be available at off-site or on-site and it can be managed by third party or organization have control over them. Whereas large organization or general public can access ***Public clouds*** which are controled and accomplished by a Cloud service provider.

• To perform application and data portability ***Hybrid clouds***are used which adjoin two or more (public or private) clouds that persist as a single entities and technology bound them together.

•When many organizations share their cloud computing infrastructure to a particular community than this is known as ***Community clouds***. It may be available at off-site or on-site and it can be managed by third party or organization have control over them.



2. Review of literature:

1. Fathey Mohammed et al., (2018) A study on "Cloud Computing Fitness for E-Government Implementation: Importance-Performance Analysis", In this paper the author discusses the cloud computing fitness for e-government implementation in which they evaluate the performance and importance of each factors that influence cloud computing system. The "task technology fit" model was used to discuss the above issues. The structured questionnaire was floated among 292 IT employees. The various factors like compatibility, security, task and relative advantage were found as a major influencing factor in cloud computing fitness model. The author used TTF and DOI model which was integrated to identify the fitness of cloud computing in e-government.

2. Nabil Sultan (2014) In his paper on "Making use of cloud computing for healthcare provision: Opportunities and challenges", The author discusses that cloud computing provide scalability and convenience to the end user in healthcare services. The various cloud computing models remove the needs of huge investment in applying hardware and software spare parts. The cloud computing in healthcare is innovative solution which provides cost effective solutions to patients and clients associated with healthcare industry. The author stated that outages, security and vendor locking are the some of the serious issues concerning with cloud computing. The study revealed that there was urge of IT advancement to overcome with above serious issues which are existing in cloud computing. The small local cloud was found more reliable and more trusted in compare to large network cloud. The author stated that selecting right cloud provider and solution is biggest challenge among healthcare organization.

3. Alex Mu-HsingKuo(2011) In their research paper on "Opportunities and Challenges of Cloud Computing to Improve Health Care Services", The researcher stated that cloud computing provides more flexibility, with cost effective and more efficiency in information technology services to end users. He stated that legal concerns and data security was most important concerns while adopting cloud computing for healthcare. The organizations like Trusted Computing Groupand the Cloud Security Alliance framed guidelines and software and hardware technologies

to perform trustful cloud computing network. PIPEDA and HIPAA is regulatory framework governed by the government to protect privacy and security of data used by end users. The author emphasizes that various factors like budget, staff, organizational culture and technologies should be consider before they implement cloud computing services in healthcare organization. HC^2SP model can be deployed in healthcare organization to govern its strategy, direction, and resource allocation.

4. Maslin Masrom et al., (2016) In this article "Understanding the Problems and Benefits of Using Cloud Computing in Malaysia Healthcare Sector", The author mentioned that several problems are existing in healthcare sector like heavy cost for setup, storage problem and absence of the system integration, while to the reduce cost, increase availability, flexibility, and scalability cloud networking deliver many assistances and opportunities to healthcare institutes. The researcher explored the various literatures that is linked with cloud computing in healthcare about Malaysia. The study results show the constraint of information about cloud networking deployed in healthcare sectors of Malaysia and demonstrate several difficulties and assistances that the cloud computing can deliver as a best IT for healthcare sector in Malaysia to resolve the current problems in healthcare infrastructure. Further the research paper emphasizes that data security and confidentiality should be more explore in cloud computing by using various security algorithms.

5. Md. Fakhrul Alam Onik et al., (2012) In their research paper on "A Secured Cloud based Health Care Data Management System", The study discusses the various encounters regarding storage of data with the implication of cloud computing. The study proposed secured cloud architecture in healthcare for managing patient database. The study comprises of CP-ABE encryption algorithm as a security manager module in the system. The users are enabled to make control on the access and by using private keys they can decrypt the encrypted files. CP-ABE algorithms overcome with the performance overhead for privacy and security of data. This can be performed as an automotive system because in the time of authorisation user has a defined category. The author stated that encryption time, key generation time and decryption time can be used further for performance analysis of cloud computing system.

6. Santhi Kannan1 et al., (2016) A study on “Performance Analysis of Cloud Computing in Healthcare System Using Tandem Queues”, In present paper they projected the model to evaluate the performance measure like waiting time of different class of unit through general public cloud that contact cloud database. They studied multiple users’ access in healthcare cloud computing which was comprises of 2 serially connected queue M/M/1 retrial queue and M/M/s queue. The SHARPE tool was used in simulating proposed model. The outcome from the proposed model shows that there is increase in the performance of cloud queuing system. The various parameters were used to measure the performance which includes cost, time and utilisation of resources. The 25 percent of total waiting time was decreased by deploying proposed simulation model and paralleled it also initiates effective utilisation of resources.

7. Yan Hu et al., (2012) In their paper on “A Cloud Computing Solution for Sharing Healthcare Information”, The author suggested that SaaS cloud computing and Google App Engine (GAE) can be used as a computing solution for distributing healthcare information. They stated that to cover the present interoperability gap in e-health the prototype designed can be helpful. The research results indicate that problems like large data table storage, high availability, quick development, authorized information can be resolve with the deployment of GAE based SaaS service They tested data in a simulation environment.

8. K. Santhi et al., (2017) In their research paper on “Performance Analysis of Cloud Computing Bulk Service Using Queuing Models”, The author discusses the cloud computing architecture by using Markovian bulk-service queue. The FCFS discipline is the major platform for the multiple class I users from the public cloud entering queue. for accessing cloud database full batch service mode and Partial batch service mode were considered appropriately. The author use queuing theory as a single server bulk service mode. The author used SHARPE tool in simulated model. The study results analysed by simulated model demonstrate that performance of the cloud queuing system increases accordingly. The total waiting time and utilisation of resources are used to measure the performance of the cloud system. In the study it was stated that simulation results presented significant variation between

the total number of users / clients and total waiting time in the system for different batch sizes and for different arrival rates.

9. HamzehKhazaei et al., (2012) A study on "Performance Analysis of Cloud Computing Centres", The researcher discussed that from the cloud providers and cloud customers perspectives the performance analysis of server farms is an important aspect in cloud computing. For the performance evaluation of a cloud computing the researcher proposed an analytical model for cloud centres. The general service time and large number of servers were considered for cloud computing environment they stated that model is flexible in terms of diversity of service time and scalability. To perform validation of model they shown numerical experiments and simulation. Numerical and simulation outcomes presented that the planned method delivered an accurate computation of the mean response time and the mean number of tasks in the system.

10. JiunnWoei Lian (2017) In their study on "Establishing a Cloud Computing Success Model for Hospitals in Taiwan", The study indicates that information quality and system quality with the implementation of IS model can directly affect the user satisfaction. The healthcare organization trust towards their business partners was directly influenced with service quality. Hence, the study results show that trust can be integrated with the implication of private cloud computing in healthcare organization whereas the understanding regarding the success of cloud computing can be improve with IS model. The study presents that trust plays important role in service quality and satisfaction. The author stated that service quality indirectly affects the user satisfaction due to its intangible properties. In hospital, cloud-based networking provides compactable, timely, reliable and clear information to the end users. This also ensures ease of use from a user perspective like healthcare professionals and patients. The study established and validate the successful deployment of IS model in healthcare organization of Taiwan.

11. Fawaz Alharbi et al., (2016) in their research paper on "Strategic Value of Cloud Computing in Healthcare organisations using the Balanced Scorecard Approach: A case study from A Saudi Hospital", The paper mentioned the use of BSC at electronic health department in hospital. The study discusses Cloud Computing from

the various strategic point of view which were internal process perspective, customer perspective, organisational capability perspective and financial perspective. The study discusses that Private Cloud Computing deliver strategic values for various perspectives with high expectations as per the financial perspective. The movement toward cost-centric model with the implementation of BSC was also discussed by the researchers. The outcomes of present paper can be used as guiding principle to perform similar projects with the consideration of uniqueness about organisation. The research paper also coated that BSC implementation can be used in overall organization as well as in specific department function.

12. Kacha Lynda et. al., (2015) In their research paper on "Data security and privacy in E-health Cloud: Comparative study" They emphasize on the data security and confidentiality in cloud computing. The researcher stated that to ensure confidentiality and to protect patient privacy, encryption remains a common solution to resolve this problem which is based on heavy computing. The patient identity and confidentiality are most important part in healthcare which should be made confidential. Anonymity of patients should be considered in e-health services. Since an anonymous medical data does not required to be encrypted as they cannot be used without the patient's identity. So, the study stressed on the balancing between the data security and the patient's anonymity.

13. QiangDuan, (2017) In their research work on "Cloud service performance evaluation: status, challenges, and opportunities – a survey from the system modelling perspective", The author performed the performance evaluation of Cloud services from the system modelling perspective which is further evaluated based on analytical modelling-based approach and measurement-based approach. The stochastic models like SRN-based methods, network calculus and queuing theory was further deployed to analyse the cloud service performance. The author also discusses the various advantages and disadvantages of typical types of approaches for evaluating cloud service performance which requires further research which was to be performed in the future work.

14. Ajit Kumar et al., (2014) In their research paper on "Deploying Cloud Computing to Implement Electronic Health Record in Indian Healthcare Settings",

they discussed about the electronic health records by using cloud computing which is more feasible and fit into desirable condition. The focus group discussion was conducted in the study to collect the qualitative data. The study was focused on three principles that is desirability, barriers and solutions in implementing cloud computing in healthcare. The study further discusses that user experience found as a most favourable attribute which was followed by security, affordability and data management. The expert group in the study suggested that hybrid computing help in storing database locally and the system can be updated with remote connection application with data server. They also discussed that cloud computing was the better option as per the complex nature of healthcare system. Client server computing was also find as one of the option to handle the personalized data of individual patient. Finally the author suggested that hybrid computing and client server computing in healthcare should be further studied in Indian healthcare system.

15. Ali Gholamiet al., (2015) In their report on "Security and Privacy of Sensitive Data in Cloud Computing: A Survey of Recent Developments", The study comprises of recent development changes in cloud computing privacy and security. The key concept like virtualization and containers were discussed in the paper. HIPAA and EU DPD legislations were discussed which are related to security and privacy of data. The author stated that cloud provider activity like resource abstraction, orchestration, cloud service management layers and physical resource ensures the security and privacy of the data.

16. Xiaolin Cheng et al., (2016) A study on "Performance Analysis of Public Cloud Computing Providers", The research study comprises of IaaS public cloud providers which was further distinguished into small cloud providers and large cloud providers. To understand the cloud performance variance Cloud screener dataset was deployed. The study examines the performance variability over time. The study set the correlation between the performance and price and comparing the performance between small cloud provider and large cloud providers. The outcomes of the study show that CPU was the key influencing factor of the performance which has positive impact on price of public cloud services. The study presents that in compare to large cloud providers, small cloud providers are more stable and efficient. The study provides a set benchmark to analyse different public cloud computing performance.

17. Leonardo Menezes de Souza et al., (2015) In their research work on "Performance Evaluation Methodology for Cloud Computing using Data Envelopment Analysis", In their study DEA methodology assist them to measure the efficiency of each experiment method where benchmark by performance and benchmark by instance was evaluated. The study mentions the impact of resources Overhead on the global performance evaluation. The author also suggested that memory and network resource performance was found most appropriate for the cloud computing system and that's why it was considered as a bottleneck. The study includes the analysis of two benchmark suites that was Phoronix Test Suite (PTS) and High-Performance Computing Challenge (HPCC). The Data Envelopment Analysis
(DEA) methodology was implemented to state the weight of each resource.

18. Sudhakar Murugesan et al., (2014) In their research paper on "Analyze and design of green computing in heath care centre", The author stated that cloud computing connects with business organization as well as with top and middle management of organization. The author emphasizes on reducing carbon emission with using clod computing with proper secured sharing network among cloud computing. The unique performance analysis was developed by using multiple PHR users and owners which provide less complex network and provide privacy guarantee. The encryption of PHR files enables patient to provide full control on their personal data. The ABE encryption can also be explored which can be used by different health professionals for examine patient data.

19. R.GowthamiSaranya1 (2017) In their research paper "A Comparative Analysis of Security Algorithms Using Cryptographic Techniques in Cloud Computing", They emphasize on data security in cloud computing by implementing efficient security algorithms. The author stated a survey report regarding various security algorithms in cloud using cryptographic techniques. The paper present that in different situation various algorithms used different protection techniques and due to this single security algorithm cannot be trusted. The author concluded that in cloud-based application multilevel security architecture is required for data security at each level.

20. S. Chaudhary &N. K. Joshi (2018) In their research paper on “Secured Blended Approach for Cryptographic Algorithm in Cloud Computing”, They stated that network and data security plays a vital role in cloud computing network. The research paper discusses the advance blend techniques to secure data. They introduce combination of AES, RSA and digital signature, where AES is symmetric, and RSA is asymmetric cryptographic algorithm. These algorithms generate private key that key will apply to digital signature which deliver data authentication in the system. The researcher using 1024 bits public key of RSA algorithm for verification process. They also analysed the performance of the same algorithm in basis of time which take less time as compare to the present hybrid algorithm.

21. B. Vinoth Kumar*et al.,* (2017) In their research paper on “Data Security on Patient Monitoring for Future Healthcare Application”, They discuss the requirement to secure the data for patient monitoring using various algorithms and find out the best inbound data security for future healthcare applications. They emphasize on integration of IOT with cloud computing to help and resolve issues involved in data security as well as data storage. They discuss the blowfish algorithm which has made an identical mark in the cryptographic field. The advantage of blowfish algorithm over the entire algorithm is that it has a long key length and ensures safety and maintains lower memory usage. This technique facilitates in developing Patient Controlled Encryption framework which supports user to store their medical records over cloud and partially share their data with chosen user.

22. Akashdeep Bhardwaja *et al.,* (2016) In their research paper on “Security Algorithms for Cloud Computing”, The researcher stated that in Information technology industry Cloud computing is emerging field for public and private enterprises. The author emphasizes on cryptography which is helpful in making data and message secure. He performed performance evaluation based on symmetric and asymmetric algorithms which compare symmetric encryption algorithms and encoding algorithms by means of time and size. The author collects performance parameter on encryption and decryption time, CPU processing time and size of payload to be examined. The study results revealed that AES as a good performer for key encryption whereas MD5 was found faster when encoding was performed.

3. Objectives:

1. To determine the key factors affecting the cloud computing security in healthcare.
2. To compare the performance of different cloud computing security algorithms used in healthcare services on the basis of Response time, security, availability of health services,and treatment response.
3. To propose application and evaluation of the proposed security algorithm for cloud services providing end-user data security for healthcare system.

4. Methodology :

The proposed research work is based on the deploymement of the services on private clouds providing healthcare services.Comparison of Symmetric encryption algorithms and encoding algorithms using factors like : Response time, security, availability of health services,and treatment response.The above mentioned factors will be studied in health cloud Salesforce.Design of security algorithm will be performed for providing the better results, as compared to existing algorithms.

Working infrastructure required:

- Environment of Programming language - Java
- Operating system Setup - 64 bit Windows 2008
- VMware based a Virtual machine Running environment.
- Over hardware as Intel Core i3-6006U CPU @ 2.0GHz, 4GB memory.

5. Significance of the Study :

The significance of the proposed stuty is to enhance the use of cloud computing in healthcare sector, so the paper work should be minimized. The PHR must be available for the access for doctors as well as patients in a very secured manner. The significance of the study

is also to provide better performance results in respect to response time, security, availability of health services,and treatment response.

5. Conclusion:

Cloud computing have become indispensable ingredients of the future information infrastructures. Evaluation of Cloud service performance is crucial and beneficial to both service providers and service consumers. Cloud computing not only helps healthcare stakeholders to solve many of their existing problems but also to deliver quality healthcare services in a timely and cost-effective manner. The adoption of cloud computing is also new challenges which faces problem like data security and privacy, lack of trust, organizational acceptance and unavailability of system development standards etc.

The suitable analysis, planning and measures should be taken into consideration before shifting to the cloud environment and hence the present proposed study is based on the performance analysis of various cloud computing tools to find out the most suitable tool for healthcare industry.

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